IOT Based Raspberry Pi Controlled Robot With Video Streamer

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Abstract*—In today's world, securityhas become a crucial part of our life. There need a monitoring service to keep track of what is happening in a particular place where security is required. Controlling a robot over the internet can have several utilities, including for security and military use.The purpose of this paper is to control robot from a remote place and stream video back to us. There are two important aspects to work with. One is to take video and watch it live from a remote place and another is to control robot vehicle to move in specified direction.The technology used for this project include Raspberry Pi with internet connectivity, a cloud server, an interface to control the robot and a web camera to take video. The program written in Python programming language is dumped into Raspberry Pi. The purpose of this program is to send video frames taken by Camera to the Cloud Server time to time refreshing every predetermined interval. One can set this interval in the client program itself. Another program called server program running on the cloud server picks up these frames. One can watch this video either typing the server IP address in the url search box in browser or we can make an android app to load this IP address and get live stream.According to the command received the program in the Raspberry Pi control the logic levels at GPIO pins of Raspberry Pi and hence motors connected to those pins will rotate accordingly to go in the intended direction.Through this setup we can monitor anything from time and time and security issue is resolved.

Keywords—
Wireless communication, Raspberry-pi, Webpage Control, Servo motor, Webcam.

I. INTRODUCTION

The rapid growth of industry and advancement of technology has resulted in reduction of human efforts, the main reason for which being machines!! Machines are playing an important role in our life. A machine might be anything, be it a cell phone or a bike or even a robot. [1][2] Robots have found an increasing demand in a wide range of applications in our life. Their use in defense has increased by the day. Our paper includes one such instance of how a bot can be of use to human race in general. Robots ensemble human beings in many ways be it looks or functioning, but previously robots were not controlled by computer programs or electronic circuitry. Back then they were built using principle of mechanics improving over time with the coming of electronic age. In today's world, robots find use in various places be it to detonate buried bombs or in industrial applications or even robotic components used in children's toys. The complexity of computer software depends on how difficult the robot's tasks are. In thisproject we use internet to establish communication between the user and a robotic vehicle. This is a reliable connection and a continuous video feedback is available to control the robotic vehicle. Due to the use of internet, there is no limitation on range or distance between the user and the robotic vehicle. Internet robotics has opened up a completely new range of real-world applications namely tele-surgery, tele-manufacturing, tele-training, tele-surgery, traffic control, health care, space exploration, disaster rescue etc. and the list is supposed to increase further in the coming years.[3] Mobile robots are generally those robots which can move from place to place across theground. Mobility gives robot a much greater flexibility to perform new, complex, exciting tasks. The world doesnot have to be modified to bring all needed items within reach of the robot. The robots can move where needed.Fewer robots can be used. Robots with mobility can perform more natural tasks in which the environment is not-designed especially for them. These robots can work in a human-centered space and cooperate with men bysharing a workspace together [2]. Nowadays, robots are increasingly being integrated into working tasks toreplace humans especially to perform repetitive tasks. The mobile robots are currently used in many fields ofapplications including office, military tasks, hospital operations, dangerous environment and agriculture.Besides, it might be difficult to the worker who must pick and place something that can affect badly[3],such asWelding is considered as a dangerous task for a humans because of toxic gases emissions, Painting has similarproblems to welding due to the use of toxic chemical products, assembly operation: When we assemble a chipwe need to be very precise because of very fine wires which require very precise and accurate tasks which ahuman cannot handle but, on the other hand, is easy for a robot and space missions to gather samples from otherplanets and to analyze them from remote distances[4].Therefore a locomotion robot can replace human to dowork. The robot is wireless controlled to ensure it can be used a long way from the user.In previous projects, many researchers have developed a system for automatic control using ZigBee, GSM or Wi-Fi modules. [4][5] Almost all systems are wired, but now we have tried the same by the use of internet. The papers we have referred to convey the use of following techniques: In Wi-Fi Robot for Video Monitoring & Surveillance System, the proposed robot motion will be controlled with PWM techniques using a Microcontroller and Bidirectional DC Bridge for Motor Driving. It is proposed to address the low cost, efficient, high speed processing & control hardware for the self-navigating robotics application. [6] Design and Implementation of a Robotic Vehicle with Real-Time Video Feedback Control via Internet paper illustrates on an approach to control a robotic vehicle using internet as

communication medium between user and robotic vehicle. Conventionally wireless robots have the drawbacks of limited working range, limited frequency range and limited control. But internet can overcome these limitations.

II. METHODOLOGY

The webcam will capture live data with regards to its surroundings and then send it to a desired device through internet. The user will be observing this data on the monitor at the user end. According to the desired movement, the user will control the robotic vehicle and the robotic arm through the webpage or keyboard available at the user end. The input given through the webpage or the keyboard is then sent through the internet and the desired movement occurs at the robot end.

A. Proposed block diagram

The first part is construction of the robotic vehicle. With the help of programs an internet connection is established between the robotic vehicle and the user. Then robot captures the images using a webcam and stores them into the memory. The next task is to capture and send live images using internet at a rate sufficient to make them seem like a live video to the human eye. This was initially implemented using LAN before moving to internet. The desired result was achieved by sending compressed low resolution images so that transmission would not be affected in case high upload speeds were not available. Then the program was made more dynamic by varying the resolution of the images to be transmitted depending on the upload speed available at that particular time. Like for example in case of availability of good upload speeds, high resolution images will be sent and vice versa in case of low upload speeds.

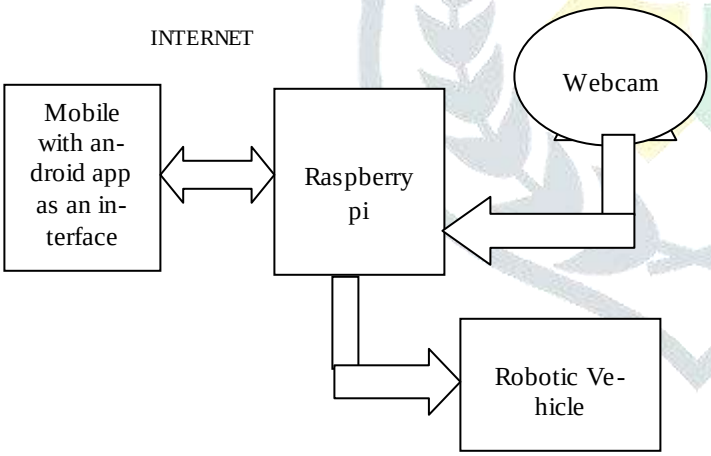

FIGURE 1. BLOCK DIAGRAM

III. DESIGN AND IMPLEMENTTION

A. Raspberry pi

Raspberry Pi is used for making robot wireless and web based.[8] Webcam is interfaced to the Raspberry Pi and then the videos are transmitted wirelessly from the robot to the user's monitor, from where the user can conveniently control the robotic vehicle's movement and also the robotic arm movement. Raspberry pi is connected with the dongle which enables raspberry pi to transmit over the web network.

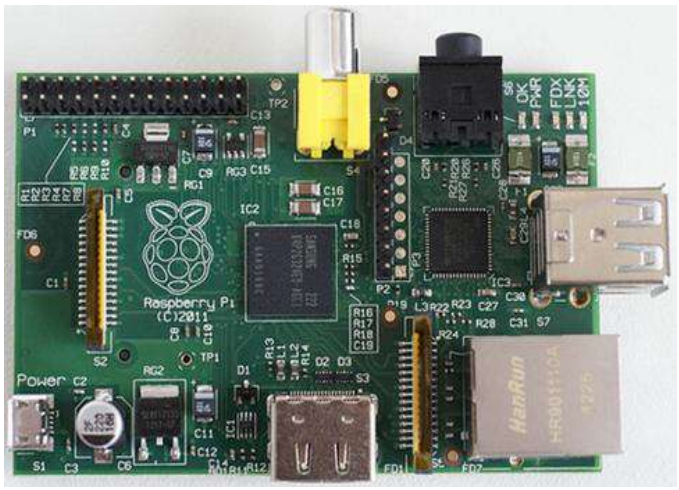

Figure 2. Raspberry-Pi Module

Raspberry Pi uses an SD card for booting and for memory as it doesn't have an inbuilt hard disk for storage. Raspberry Pi requires 5 volt supply with minimum of 700-1000 mA current and it is powered through micro USB cable. ARM11 only requires 3.3 volt of supply which it takes with the help of linear regulator. 5 volt is required for the USB ports. It operates at 700 MHz We use python or embedded C to write the code into the raspberry pi. It has a strong processing capability due to the ARM11 architecture and Linux-based system. In terms of interface and control, it has 1 SPI, 1 UART, 1 I2C and 8 GPIO, which basically meet the control requirement. There are easy to use open source peripheral driver libraries. [9]

B. Robotic Arm

It should have three rotational joints along with a gripper. The gripper will open and close by means of the gear wheels. The base rotates in circular direction and the other two joints for upward, downward and forward, backward motion respectively. There is a limit to the movement each joint can produce since each joint is controlled by a servo motor. [10]

C. Web cam

The visual feedback is provided by the Intex IT-306WC webcam. It can have a resolution of up to 30.0MP, Frame rate of 30FPS along with night time vision. It is plugged into the USB port of the Raspberry Pi.

D. Motor driver circuit

This circuit consists of the motor driver IC l293d used to power the DC motors. [11] These DC motors will be used to maneuver the robotic vehicle.

E. Software Design

Python programming is used here. [12] Software design is divided into 4 codes namely:

a)Webcam Server Webcam Server is the code run in the Raspberry Pi to capture the images and stream them over the internet. Here the images will be compressed into .jpg format to reduce their size prior to their transmission over the internet. They are sent using byte array over the UDP socket. [13]
b) Webcam Client Webcam Client is the run in by the user to receive this images in the form of byte array. The are then displayed on the monitor at a rate closer to 12-20 images per second so that they appear like a continuous video.[14]
c)Motor Server Motor Server is run by the user. Monitoring the video, the user maneuvers the robotic vehicle or the robotic arm accordingly. This is done by accepting input either

from the keyboard or the webpage. It is done by checking the key press events.

d)MotorClient As per the input from the user, either the robotic vehicle or the robotic arm move. This is done by making High or Low the desired GPIO pins of the Raspberry Pi. 4 GPIO pins are connected to the 4 servo motors and 4 to the motor driver IC l293d.[15]

IV. FLOW CHART

Flowchart is shown in Figure 3.It explains the manner in which actions will takes place here. So, initial stage is to capture the data with the help of a webcam. Then that data will be transmitted to the monitor side. According to presented situation, user will takes necessary actions like picking or placing any object or it can be movement of vehicle. But it will be in terms of signals, which will be transmitted through the internet. When these signals are received by the raspberry pi placed on vehicle, the robotic arm and vehicle will move accordingly. [16] Again webcam will capture and send images to the user to take action. This cycle will go on.

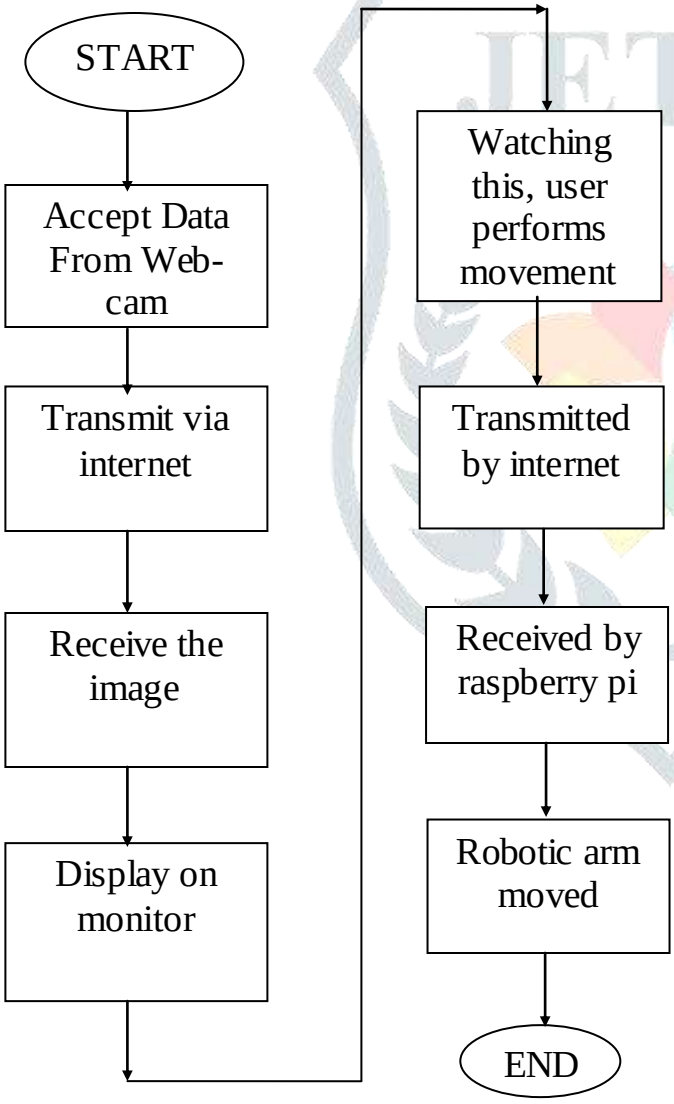

FIGURE 3. FLOW CHART

V. RESULTS

The entire design process if of two phases:

1.Controlling ROBOT Vehicle via android mobile app.

2.Streaming video from Robot Vehicle on android app.

Phase 1: Controlling ROBOT vehicle via android app

1.There are many ways to accomplish this. We made use of PHP scripting and MySQL database.

2.First of all we need to design a PHP script to store our control data sent from android app in a MySQL database. So we wrote a simple PHP script which accepts data sent and stores it in a MySQL database.

3.Now we got our script ready. The next step is to send data to that script through android app. We designed an android app which has four buttons viz LEFT, RIGHT, FORWARD, BACKWARD. On pressing these buttons corresponding control data is sent to PHP server and data gets stored in the Database.

4.Then we need a way to fetch this control data to Raspberry Pi. We wrote another PHP script to fetch control data from database.

5. Python script in the Raspberry Pi makes a request to this PHP script i.e., getdata.php and receives the control data as response.

6.Based on the control data the motors are rotated correspondingly.

Phase 2: Streaming video from ROBOT vehicle on android app

1.For this, we made use of a library called OpenCV for capturing video from a Web Camera attached to the Raspberry Pi. OpenCV (Open Source Computer Vision) is a library of programming functions mainly aimed at real-time computer vision.

2.For transferring the video, we used client server socket programming model of python.

3.There are basically two scripts. One is server script and other being client script. Server program binds to a port address and waits for connections from clients. Client program connects to that IP address and connection is established.

4.Now the video is sent frame by frame to that server. Server assigns these frames to a port number. When we open that address (IP address : Port number) , then video is streamed.

5.The next step is to fetch that address from android app. We integrated this functionality by using Web View in android app. The video then gets streamed in android app.This way we can both control Robot Vehicle and watch video from anywhere.

Above figure.5 shows the IOT video stream android app. As mentioned previously it has controls such as LEFT , RIGHT, FRONT ,BACK and displaying live video.This way we can both control Robot Vehicle and watch video from anywhere.

DESIGN STEPS:

Step1: Setting up the raspberry pi. In this step go to raspberrypi.org and download any operating system you required but here we used Raspbian Wheezy.

Step 2: Install the required packages in the pi and connect the webcam to the pi, after this you will get MJPG-streamer folder.

Step 3: Design the Login page for the authentication of robot and create the database for accessing. Here we designed the page using HTML, CSS and PHP and data base was created by using MySQL.

Step 4: Now, we need wifi dongle to connect our Pi with wifi router. After connecting wifi dongle to PI, open WiConfig

application (you can find this application pre installed in raspbian OS) & connect your PI with your wifi router. If it is already connected with wifi router, execute following command into terminal to know IP Address (ifconfig).

Step 5: You will find IP address of Pi in output. Do remember this IP Address for further use. We will need it control your Robot.

Step 6: Now build Robot, We can use DC Motor based simple robot. To control your motors we need L293D or L298 IC. Here we connected GPIO pins 18,4 with L293/L298 IC to control Left Motor & 23, 24 pins with L293/L298 IC to control Right Motor.

Step 7: Power Supply, Now the biggest challenge for any autonomous machine is power supply. Here we used 12v rechargeable Ni-MH battery. But as per specifications Pi will work on 5 V, So we use LM317 to regulate it to 5v. We connect battery terminals directly to motor driver IC, also parallelly, connect it to input of LM317 IC and regulated it to 5v by adjusting the resistance. 5 V output of this IC is connected withFirst GPIO of Raspberry Pi B+ in to power up it.

Step 8: After connecting all the connections check it once again because if any wrong connections happened then definitely pi will be burn and see that you are giving power supply correctly that is in between 4.9v-5.2v

Step 9: As soon as you connect 5V supply with Pi it will turn on, you can see green LED blinking while start-up process. After some time open browser in your Laptop and write down following link: IP address /filename.

Now sitting in your room you can stream video and control the robot anywhere in the world.

Step 10: As soon as you connect 5V supply with Pi it will turn on, you can see green LED blinking while start-up process. After some time open browser in your Laptop and write down following link: IP address /filename.

Now sitting in your room you can stream video and control the robot anywhere in the world.

VI. CONCLUSION

Paper contains detailed information for controlling a robotic vehicle guided via internet. It has been done with the use of TCP and UDP protocols for transport layer data transfer. The size of the images sent by the robotic vehicle is controlled by a feedback. This feedback signal determines whether the size of the image should be small or large depending on the upload speed available with the Raspberry pi, thus making it much more dynamic to stream live visual data along with the successful movement of the robotic vehicle and the robotic arm. Faster communication will ensure that we can send high quality, high resolution images with minimal delay or latency. This will help reduce delay in execution of commands providing real time access to the robot. It will be of great use for monitoring illegal activities occurring around us. It will also be useful in disaster affected areas to find and rescue injured people. It would also be used for spy bot.

VII. FUTURE SCOPE

The time delay which occurs in the execution of commands has to be reduced and thus we can have real time access to the robot. With reduced time delay we can have faster operation and quick response to any illegal activities in the monitored area. This system can also be used in the disaster (earthquakes, mine collapse) areas to find any injured persons and give information to rescue teams.

It has countless applications and can be used in different scenarios and environments.

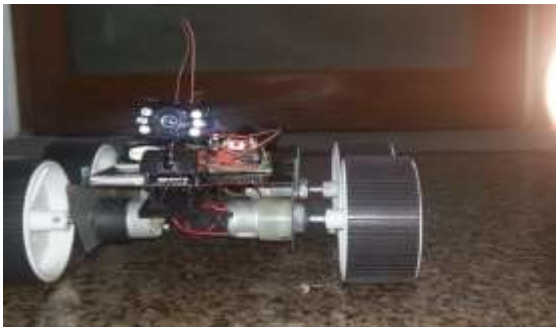

Figure 4. Robotic vehicle

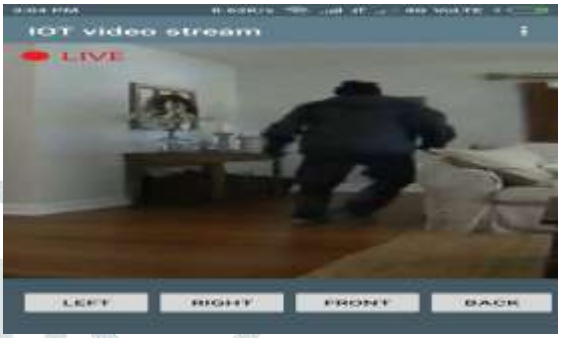

Figure 5. IOT Video stream android app

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